DOCUMENT RESUME

ED 449 023 SE 064 385

AUTHOR Ferreira, J. M. Martins; MacKinnon, Lachlan; Desmulliez, Marc; Foulk, Patrick
TITLE A Multimedia Telematics Network for On-the-Job Training, Tutoring and Assessment.
PUB DATE 1998-00-00
NOTE 7p.; Paper presented at the Annual Meeting of the International Conference on Engineering Education (Rio de Janeiro, Brazil, August 17-20, 1998). The figure will not reproduce well.
PUB TYPE Reports - Descriptive (141) -- Speeches/Meeting Papers (150)
EDRS PRICE MF01/PC01 Plus Postage.
DESCRIPTORS Educational Technology; *Engineering Education; Foreign Countries; Higher Education; *Multimedia Materials; *Program Descriptions; Science Education; *World Wide Web

ABSTRACT

This paper describes an educational multimedia network developed in Advanced Software for Training and Evaluation of Processes (ASTEP). ASTEP started in February 1998 and was set up by a mixed industry-academia consortium with the objective of meeting the educational/training demands of the highly competitive microelectronics/semiconductor industry. The ASTEP consortium is led by the Heriot-Watt University in the United Kingdom and brings together universities and companies from five European countries that include the United Kingdom, Portugal, France, Norway, and Germany. The industry part of this consortium is related to semiconductor fabrication and microsystems manufacturing and includes Motorola (the factories in East Kilbride, UK and Toulouse, France), Applied Materials GmbH (Germany) and SensoNor (Norway). (Contains 18 references.) (ASK)

Reproductions supplied by EDRS are the best that can be made
from the original document.

PERMISSION TO REPRODUCE AND DISSEMINATE THIS MATERIAL HAS BEEN GRANTED BY

M. Ferreira

TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)

1

U.S. DEPARTMENT OF EDUCATION
Office of Educational Research and Improvement
EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)

☒ This document has been reproduced as received from the person or organization originating it.

☐ Minor changes have been made to improve reproduction quality.

• Points of view or opinions stated in this document do not necessarily represent official OERI position or policy.

ED 449 023

A multimedia telematics network for on-the-job training, tutoring and assessment

Martins Ferreira (1), Lachlan MacKinnon (2), Marc Desmulliez (2) and Patrick Foulk (2)
(1) University of Porto (FEUP/DEEC) - Rua dos Bragas - Porto – PORTUGAL
(jmf@fe.up.pt)
(2)Heriot-Watt University - Edinburgh EH14 4AS – UK (L.M.MacKinnon@hw.ac.uk)

Abstract

*This paper describes an educational multimedia network currently being developed in ASTEP, a project funded by the European Commission under the Educational Multimedia / Telematics Applications programme. ASTEP (*Advanced Software for Training and Evaluation of Processes*) is a 2-year project which started in February of 1998 and is set up by a mixed industry-academia consortium with the objective of meeting the educational / training demands of the highly competitive microelectronics / semiconductor industry.*

The ASTEP consortium is led by the Heriot-Watt University in the UK and brings together universities and companies from five European countries (UK, Portugal, France, Norway and Germany). The industry part of this consortium is related to semiconductor fabrication and microsystems manufacturing and includes Motorola (the factories in East Kilbride in the UK and Toulouse in France), Applied Materials GmbH (Germany) and SensoNor (Norway).

Introduction

Traditional engineering education in the area of semiconductor manufacturing is presently unable to satisfy the growing need for qualified professionals in an area that is vital both in economical and strategical terms in Europe. The reason for this fact is due not only to the difficulty of producing enough engineers for such a growing demand, but also to the difficulty of reliably predicting the demand itself (which is largely the consequence of an unstable and frequently random worldwide semiconductor market).

The exceptionally fast pace at which the technology evolves in this area is another reason for concern, since a permanent update of the technical skills of their staff is vital for the competitiveness of any semiconductor company. Again this need is not easily met by traditional engineering education, in this case also because semiconductor companies can hardly afford to send their technical staff away for training. Several companies developed their own ways to cope with this problem, frequently by creating their own advanced training facilities (such as the Motorola University).

Distance learning technology is however becoming sufficiently mature and promises to open up flexible training alternatives that are able to overcome two major difficulties for course delivery: those related to place and time. Virtual classrooms can accommodate any number of trainees and provide training schedules adaptable to each trainee's occupations. Currently available web-based training technologies and the awareness of the importance of multimedia telematics networks for the delivery, support and assessment of trainees, for process-based high technology companies, were therefore the key factors that led to the ASTEP proposal.

The next section presents an overview of web-based training, both in terms of organisational models and course management tools. The relevance of web-based systems for on-the-job training in Europe will also be considered. The following section will then present the ASTEP project, including the user needs addressed, the workplan of the project and the framework being developed, as well as the consortium carrying out this effort. A concluding section and a number of relevant references in this area will then close this paper.

Web-based training

With over one million pages already registered on Internet search engines in 1997 and a forecast of 200 million people on-line by the year 2000 [1], web-based training plays a fundamental role in the global market of distance education [2,3]. Moreover, with commercial applications for Internet telephony within sight and emerging technologies promising to match ISDN quality, the improvement in synchronous teaching / learning mechanisms reinforces the potential of the web for the delivery of training courses.

Even with the expected improvement in communications, there are still disadvantages in web-based training [4]: acquaintance with course management tools is an unavoidable overhead which will be present whenever new tools are adopted; and the presence of the technology link in the teaching / learning process requires the availability of technical support in both sides. There are also other disadvantages, namely the general risks of global education, which will be shortly addressed in the following section. However, and in spite of its drawbacks, the use of the web for course delivery has several important advantages:

- A training programme can be set up with little dependence on the number of trainees, which is of

SE 064 385

particular importance when this number is too large or too difficult to estimate over the years
- Trainees are able to make the best use of their time, according to their occupations at any moment and to the need they feel to improve their professional skills

Access to information and discussion fora in widely dispersed sites is much easier, enabling the fast acquisition of in-depth knowledge when required

The number of applications and case studies already available for the assessment of web-based training provide evidence that it is important to decouple the organisational model and the actual technology employed for course delivery. The most relevant issues in these two areas will therefore be outlined separately in this paper.

Organisational models

The traditional classroom-based environment has well known organisational / pedagogical models, which however have to be reformulated to accommodate some of the characteristics of the distance education process. The components of the instructional process are basically the same, but the "distributed classroom" requires its own organisational model because in this setting the faculty / institution control is largely replaced by student control. The planning process leading to distance course delivery and assessment will have to take into account a number of issues before the next step (which course management tool) is taken [5], namely the following:

- Logistical aspects, such as the procedures for the distribution of materials, assessment of students, course management, how to deal with laboratory work requirements, etc.
- Student support procedures, including contact with advisors and access to library and other campus facilities
- Faculty support, namely in terms of training and technical support concerning the course delivery tools to be used
- Evaluation procedures, including evaluation of the faculty staff and resources made available to the students

The instructional design process for Internet-based education must be clearly understood in all its phases: analysis, design, production and pilot testing, implementation and evaluation [6]. It is also important that the risks of global education are considered at this stage and preventive measures taken. These risks are detailed in [7] and involve the following main aspects:

- Cognitive issues associated to the breakdown of linear, narrative structures, which are replaced by the fragmentation and superficiality of hyperlinked structures
- Educational quality, which may be hampered by the effect of economical and competitiveness forces in a global market
- Social challenges induced by the breakdown of community links
- Local cultures are at risk of being colonised by prevailing cultural trends in those countries technologically ahead

It must be emphasised, however, that the availability of better communications infrastructures will contribute to diminish the gap between on-site and distant learners and increase the similarity of experiences in both cases [8]. Synchronous teaching / learning procedures in web-based course delivery will become easier to implement and more effective, and will in the near future enable organisational models which will preserve the best characteristics of the two extremes (faculty / institution control in the traditional classroom environments and student control in independent learning settings).

Course management tools

There is a considerable range of tools available for online course development and delivery. The offer provided by multimedia courseware authoring system vendors is sufficiently wide to cover the main categories of products required for web-based training, such as those identified in [6]: the creation of media elements (text, graphics, audio, etc.), WWW publishing, Internet-based conferencing, Internet enabled multimedia authoring and integrated distributed learning environments.

Selecting the appropriate tool for online course development and delivery is therefore a complex task and requires an in-depth analysis of both organisational and technical factors, which goes beyond the scope of this section. A comprehensive list of the elements that have to be considered for this purpose can however be found in [6], which also presents a comparative analysis of the characteristics of tools available for the five broad categories referred previously.

Benchmarks comparing the main tools for course management should also be considered as a first guide to the range of products available in this field. Quick reference comparative studies can easily be found, such as those referred in [3,9], covering most of the tools available on the market: TopClass, LearningSpace, Authorware 4, QuestNet+, ToolBook II, Phoenix for Windows, IconAuthor, Virtual-U, WebCT, Web Course in a Box and Interactive Learning Network, among others.

On-the-job training in Europe

The Education and Training Sector of the Telematics Applications Programme is at present one of the main driving forces in Europe towards the goal of equal access to lifelong learning for all European citizens. The roots of telematics applications for education and training in Europe go back to the start of the DELTA (Development of European Learning through Technological Advance) programme in 1988 and continued with the Telematics for Flexible and Distance Learning Programme which run from 1990 to 1994 [10]. A detailed description of 39 recent and on-

BEST COPY AVAILABLE

going projects funded by the European Commission on the Education and Training sector can be found in [11].

Representative examples of this effort can be found in [12,13,14,15,16,17], which describe projects in both large and small companies. The TECAR project [12,16] (training in the automobile sector), involving Mercedes-Benz and Fiat, is a good example to illustrate the importance of on-the-job training for the European industry. The TECAR framework started as an Intranet-based WWW site and involves a telecommunications platform based on Europe-wide ISDN. Frameworks for web-based course delivery in Europe are also available outside the industrial arena, as may be illustrated by the case of meteorologists [17]. The EuroMET project was developed by 24 meteorological institutions in 15 countries and is the first European web site for education and training in meteorology.

Other examples that might be used to illustrate the importance of on-the-job training in large companies are those involving Deutsche Telekom [13] and Telecom Italia [14]. Considering that Deutsche Telekom organises 16,000 training courses each year, involving 156,000 participants and 600,000 days of training, it is easy to understand that online delivery of course material is of strategical importance for any large company or organisation. As an example within the ASTEP project consortium, it is important to refer that the semiconductor company Motorola has a world-wide policy to provide 30% of training and development using alternative learning technologies (CBT, CD-ROM, CDI, IVI, Linear Video, video conferencing, Internet) by the year 2001.

The ASTEP project

A large number of people world-wide are currently employed in the highly competitive high technology microelectronics industry, where the demand for highly skilled professionals will continue to increase in the foreseeable future. This demand requires a combined effort by universities and industry, where the engineering excellence required by the latter can only be met through innovation in two main areas: curricular contents and distance / continuing education. Innovation in curricular contents has long been perceived as a fundamental issue in many universities, but the importance of interactive multimedia telematics networks is only now starting to be widely perceived and was the main reason that triggered the ASTEP project.

The multimedia framework envisioned by ASTEP captures the synergies of interactive multimedia technologies and global communication infrastructures, into a telematics network for the delivery, support and assessment of trainees for process-based high-technology companies. This network will enable highly flexible strategies to bring tutor expertise to the factory floor in a manner that gives high priority to such aspects as richer / more attractive presentation techniques, diversity of personal training schemes and quality assessment methods in the training process.

User needs addressed in ASTEP

Fundamental to the nature of this project is the intention to produce a generic ASTEP framework which could be used to support training of staff for any process-based industry. However, the user needs to be covered during the duration of the ASTEP project were defined as to address the main problems currently faced by training of technical staff working in the semiconductor industry:

- The nature of the jobs within this industry (24-hour, 7-day continuous production) precludes the traditional delivery and tutoring of teaching material.
- An essential requirement throughout the industry is to provide training in a flexible manner, so as to make it cost-effective and meet the needs of both the company and the individual.
- It is difficult to give trainees access to manufacturing areas and an appreciation of the operation of equipment without interrupting production or disrupting essential work.
- There is a particular need, because of the rapidly evolving technology, to continually upgrade the skills of the present workforce to maintain the competitiveness of the industries within Europe.
- The relatively large distances from learning institutions prevent companies from sending large numbers of trainees for education.

Most companies have existing in-house training courses that are used to train new operators, technicians, engineers and designers. Such courses can be delivered at varying levels of complexity, depending on the user needs and abilities. They cover the fundamentals of semiconductors, the manufacturing process, the construction of active devices and the equipment used in production.

A user needs team will be created to survey the deficiencies of current training material and delivery mechanisms, so that these drawbacks are addressed by the project. After this review process, each group will indicate which aspect of the training material needs to be expanded or modified. As far as the multimedia framework is concerned, these same groups will interact with each other in order to provide a common specification document which reflects the user needs.

The ASTEP workplan and framework

The purpose of the ASTEP project is to create a multimedia educational platform and a European telematics network for the delivery, tutoring and assessment of trainees employed in process-based high-technology companies. To prove the capabilities and benefits of this platform and network, the following sets of courses will be designed:

- Proprietary semiconductor processes (Motorola and SensoNor)
- Generic semiconductor process

BEST COPY AVAILABLE

- Test and High Level Design

At the end of the project, the trainee will be able:

- To learn the manufacturing process and characterisation techniques at each step of the process.
- To diagnose and evaluate any deviations of the process from the nominal one.
- To share peers' experience and the latest technological breakthroughs through the telematics network.
- To be able to acquire a Nationally recognised diploma through tutor support and assessment modules of the learned material.

The delivery of the project is articulated around seven workpackages, one of which is the management workpackage WP01. The conversion of course material into a suitable multimedia format and its telematics delivery framework is carried out in WP02 in the specific cases of the Motorola and generic semiconductor processes. The workpackage WP03 ensures the developed methodology applies, as planned, for the three other modules. The demonstration and exploitation procedures are carried out in WP04 for the Universities, Colleges as well as Companies. WP05 is devoted to the pursuit of National and European recognition of qualifications of the trainees who have taken part in the course. WP06 will ensure that, at all phases of the development procedure, quality assurance is monitored and guaranteed. WP07 will look at the sustainability of the network and the dissemination of the modules for a broader audience.

Once a generic model of ASTEP has been developed, a standard commercial alpha-beta test model will be adopted. Alpha testing will be carried out at Industrial and Academic partner sites with test data, related but not necessarily specific to the domain, instantiated into the framework. The framework will be evaluated for usability, consistency, speed, and the efficiency of the delivery of material, specifically multimedia assets across telematic links.

The alpha-test results will be incorporated into a full production-level version of the ASTEP environment, which will then be customised fully for the chosen demonstrator domain, semiconductor manufacturing. The full, product-level version of ASTEP will then be installed, as for the alpha-test version, at the Industrial and Academic partner sites.

Figure 1: Geographical distribution and individual roles within the ASTEP partnership

Structure for the beta-test evaluation will be determined jointly by all partners, based on using a discrete component of the process model and associated ASTEP material and support framework with a selected group of users in each of the beta-test sites. Typical course delivery will involve experts and trainees interacting via a telecommunications infrastructure networking the 5 countries in the consortium, as illustrated in figure 1.

Beta-test results will be incorporated into a final, product release of ASTEP as a generic framework, and an industry-specific release of ASTEP for the semiconductor manufacturing industry. User group newsgroup, mailing list, or other appropriate telematic structures will be developed to provide ongoing support and feedback structures relative to the further development, maintenance and exploitation of ASTEP. This structure will be distinct from the support framework provided within ASTEP itself, for users in a particular domain. As part of the exploitation plan for the project, appropriate feedback response times, formats and actions will be identified and responsibilities assigned to partners within the consortium.

The telematics infrastructure uses conventional and well-proven technologies. The objective is to use Intranet capabilities with Internet connections between members of the consortium. To take fullest advantage of the growing network infrastructure, video conferencing over ISDN will be used, structured around work groups. Many companies have an "Intranet" within all their sites. Such a tool will allow individuals to be trained wherever they are in Europe, giving the possibility, for example, of a new employee in a sales office to get the same level of training as a person at a manufacturing site.

Specifically, multimedia technology will be used to attempt to provide:

- **2D Visualisation and/or animation of specific processes** within the production environment, permitting detailed exposition of techniques and skills required, safety factors, sequencing and timing issues.

BEST COPY AVAILABLE

- **3D Visualisation of processes or artefacts** to permit multi-point viewing, internal walkthroughs, structural deconstruction, and surface, rotation and light-source modelling.
- **Role-play interactive video**, permitting students to make decisions on progress at strategic points within processes in the production environment, with multiple realistic outcomes to reflect the students decisions on these processes.
- **On-line, language-specific, hypermedia help facilities**. Visual material will be edited and layered to allow the synchronisation of digital audio in the different languages.
- **Question and answer database**, available to all students either on-line or stand-alone, providing a FAQ-style browsing capability and a structured keyword search capability. The database to be initially seeded with anticipated Q&A dialogues, and then updated with additional actual student – tutor / expert dialogues. Answers stored in the database will encompass all media types. The use of audio or visual mail is especially important if technical problems related to the manufacturing process are encountered.

The ASTEP project will integrate telematics with its core modules. The support offered **through telematics** apply at different points:

- The materials: with **Internet connectivity** material can be delivered from the most up-to-date source on a remote server.
- The question and answer database: this will be updated continuously as users interact with it over the Internet.
- Asynchronous contact: **electronic mail** and discussions will be used through the Internet to support the ask model in ASTEP.
- Synchronous Internet support: tools such as **text chat and audio tools** can be supported through the Internet
- Synchronous ISDN support: application sharing using the T120 standard can be provided over **ISDN alongside video conferencing**.

It can therefore be seen that the use of such telematics infrastructure allows for different levels of accessibility as shown in table 1 below:

Table 1: The ASTEP telematics infrastructure.

ISDN	Video contact
Permanent Internet connectivity	Synchronous contact Direct access to remote servers
Internet connectivity	Asynchronous communication Updating of question and answer database
No connectivity	Core material Local version of question and answer Simulations on local servers are all available

The validation procedures will be implemented through the use of small groups of typical users of different countries, educational ability and professional background. The groups will mimic the series of scenarios considered in the ASTEP pedagogical model and report their experience in focus meetings. In that respect, comments on evaluation usability, acceptance testing, user-friendliness, appropriateness of contents are fed back to correct and improve the future products.

The ASTEP consortium

The consortium is composed of learning institutions at the engineering (Heriot-Watt University – HWU, Faculty of Engineering of the University of Porto – FEUP, Buskerud College of Engineering – HIBU) and technician (West Lothian College - WLC) levels, industrial high-technology companies and validation sites (Motorola, SensoNor, Applied Materials), national institutions (National Microelectronics Institute) and experts in educational distance learning and multimedia (HWU, FEUP). Their particular skills and relative role in the overall project goals may be described as follows:

- The Companies Motorola UK and Motorola France for the development, testing and exploitation of the proprietary process package.
- The Company SensoNor Norway for the development, testing and exploitation of the proprietary process package.
- The European Teaching Organisation of the company Applied Materials Germany for the development and testing of the generic process package.
- The Colleges Buskerud Norway and West Lothian College Scotland for the development, testing and exploitation of the generic process package.
- The Faculty of Engineering of the University of Porto (FEUP), combined with other Portuguese Universities, for the development, validation and exploitation of the Test and High-Level Design package.
- Heriot-Watt University expertise in computer-based learning, project co-ordination and management.

It should be emphasised that all partners of the proposal are future users of the ASTEP products, either as lecturers, company trainers or employers. In the partners' interest, user groups and user representatives are therefore included at every stage of the project.

Conclusion

The importance of distance education and training is now widely recognised and is indeed a clearly defined goal in the strategical development plan of most major companies and organisations. Developments in Internet technology are expected to minimise the bottlenecks preventing faster data transmission rates,

BEST COPY AVAILABLE

making web-based course delivery a widely available solution in this area.

In recognition of this trend, the ASTEP project was set up to develop a multimedia framework embedded within a European telematics network for the delivery, support and assessment of trainees for process-based high-technology companies. Besides the companies which will train their technical staff, the universities that are part of the ASTEP consortium are committed to evaluate the usefulness of the resulting multimedia telematics network for improving the quality of the engineering education provided to their students.

Last but not least, it is also important to acknowledge the importance of web-based tools for course delivery to persons with special needs. Although the availability of results in this area is still scarce [18], there is an enormous potential to widen access to education and training for the whole community of people whose impairments make it difficult to attend traditional on-site classroom environments.

References

[1] Eberl, Ulrich, "Where the Web is Going," *Siemens Research and Innovation*, 2/97, pp. 9-15.

[2] Khan, B. H. (ed.), *Web-Based Instruction*, Educational Technology Publications, 1997 (480 pp.).
[**Error! Bookmark not defined.**]

[3] Bethoney, Herb, "Computer-based training on the web," *PCWeek*, August 1998.
[**Error! Bookmark not defined.**]

[4] The University of Manitoba, *Advantages and Disadvantages of Web Based Instruction*.
[**Error! Bookmark not defined.**]

[5] Institute for Distance Education (University System of Maryland), *Models of Distance Education*, 1997.
[**Error! Bookmark not defined.**]

[6] TeleEducation NB, *A Survey of New Media Development and Delivery Software for Internet-Based Learning*, 1997.
[**Error! Bookmark not defined.**]

[7] Mason, Robin, *The Globalisation of Education*, 1997.
[**Error! Bookmark not defined.**]

[8] Graziadei, W. D., Gallagher, S., Brown, R. N., Sasiadek, J., *Building Asynchronous & Synchronous Teaching-Learning Environments: Exploring a Course / Classroom Management System Solution*, January 1998.
[**Error! Bookmark not defined.**]

[9] Landon, Bruce, *Online Educational Delivery Applications: A Web Tool for Comparative Analysis*, September 1997.
[**Error! Bookmark not defined.**]

[10] Balbot, Jacques, "10 Years of Telematics Applications for Education and Training in Europe," *Proc. of the EuroChinatel Conference (Telematics Multimedia Applications for Education and Healthcare)*, April 1997, pp. 71-73, Beijing.

[11] European Commission, *Education and Training in the Telematics Applications Programme*, catalog of (39) recent and on-going projects.
[**Error! Bookmark not defined.**]

[12] Peltason, Christof, "Training in the Automobile Industry: The TECAR project," *Proceedings of the EuroChinatel Conference (Telematics Multimedia Applications for Education and Healthcare)*, April 1997, pp. 151-155, Beijing.

[13] Elz, Willi (Deutsche Telekom), "Telelearning in a Large Company," *Proceedings of the EuroChinatel Conference (Telematics Multimedia Applications for Education and Healthcare)*, April 1997, pp. 156-171, Beijing.

[14] Pucci, Luciano (Trainet, Telecom Italia), "Distance Learning for Major Organisations: The Key Issues," *Proc. of the EuroChinatel Conference (Telematics Multimedia Applications for Education and Healthcare)*, April 1997, pp. 181-193, Beijing.

[15] Guillen, S., Flores, J., "The Permanent Training Support System (PTSS): On-the-job Training by Internet," *Proc. of the EuroChinatel Conference (Telematics Multimedia Applications for Education and Healthcare)*, April 1997, pp. 228-237, Beijing.

[16] Brossmann, M., "Telematics for Training in the Automobile Industry," *Proceedings of the European Telematics Conference: Advancing the Information Society*, February 1998, pp. 194-197, Barcelona.

[17] Duncan, C., Gondouin, D., Delsaux, F., "Multimedia Based Training for Professionals: The Case of Metereologists," *Proceedings of the European Telematics Conference: Advancing the Information Society*, February 1998, pp. 276-280, Barcelona.

[18] Blackhurst, A. E., Hales, R. M., *Using an Education Server Software System to Deliver Special Education Coursework via the World Wide Web*, 1997.
[**Error! Bookmark not defined.**]

BEST COPY AVAILABLE